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ENVIRONMENTAL MONITORING REPORT ON THE U.S.
DOE'S INACTIVE MILLSITE FACILITY CY 89

Environmental Monitoring Report on the U.S. Department of Energy's Inactive Millsite Facility, Monticello, Utah, for Calendar Year 1989

May 1990

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ENVIRONMENTAL MONITORING REPORT
ON THE U.S. DEPARTMENT OF ENERGY'S
INACTIVE MILLSITE FACILITY,
MONTICELLO, UTAH, FOR
CALENDAR YEAR 1989

The U.S. Department of Energy
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SUMMARY

The inactive Monticello Millsite is located in San Juan County, Utah, just south of the town of Monticello. Environmental monitoring at the site is funded by the Surplus Facilities Management Program (SFMP) and focuses on releases related to preexistent mill tailings. All contaminant discharges result from the leaching of uranium-mill-tailings-related elements by ground water and surface water, and from the release of radon gas and particulate matter into the atmosphere. Pathways facilitating the migration of contaminants from the Monticello site include ground water in the shallow alluvial aquifer underlying the inactive facility, surface water running across the site, and atmospheric transport.

The shallow aquifer underlying the Monticello property is contaminated by leached products of uranium mill tailings. The Uranium Mill Tailings Radiation Control Act (UMTRCA) ground-water standards and the Environmental Protection Agency (EPA) and the State of Utah drinking water standards specify limits of 0.05 milligrams per liter (mg/L) arsenic, 5 mg/L radium, and 0.01 mg/L selenium; maximum concentrations of these elements recorded in 1989 were 0.14 mg/L, 16.7 mg/L, and 0.85 mg/L, respectively. Proposed UMTRCA ground-water standards for molybdenum and uranium are, respectively, 0.1 mg/L and approximately 0.45 mg/L (the actual standard is given as an activity, 30 pCi/g); maximum concentrations recorded in 1989 were 1.34 mg/L molybdenum and 5.4 mg/L uranium.

Montezuma Creek, which flows through the property, has frequently contained contamination at levels exceeding State of Utah surface-water standards for 3-5 kilometers (2-3 miles) downstream of the property. Contamination of the creek results from discharge from the contaminated alluvial aquifer. During 1989, maximum concentrations of arsenic, radium, selenium, and gross alpha recorded in the creek exceeded their respective standards of 0.05 mg/L, 5 mg/L, 0.05 mg/L, and 15 mg/L. Historically, the aquifer discharge has also caused the uranium concentration in the creek to increase by as much as an order of magnitude. Montezuma Creek is used for both irrigation and livestock watering in the vicinity of the site.

Extensive measurement of radon contamination from the tailings piles was conducted during 1984, 1985, and to a lesser extent during 1986, 1987, 1988, and 1989. On-pile, site-boundary, and off-site atmospheric radon measurements, as well as on-pile radon-flux measurements, were taken. Results of these measurements demonstrate that the Environmental Protection Agency (EPA) standard for radon emissions ($20 \text{ pCi} \cdot \text{m}^{-2} \cdot \text{sec}^{-1}$) from inactive uranium processing sites is exceeded at all four tailings piles at the Monticello site.

Air particulate monitoring was conducted during 1989 at one on-site and two off-site locations with high-volume Sierra-Anderson air particulate samplers. So that only the inhalable particles would be collected, 10-micron-size screens were added to the samplers. The maximum airborne concentrations of radium-226, thorium-230, and uranium were all several orders of magnitude below the regulatory limits ($3 \times 10^{-12} \text{ } \mu\text{Ci/g}$ radium-226, $8 \times 10^{-14} \text{ } \mu\text{Ci/g}$ thorium-230, and $3 \times 10^{-12} \text{ } \mu\text{Ci/g}$ uranium) specified by DOE Order 5480.1 (now superseded by DOE Order 5400.5). The maximum concentrations of lead were

below the EPA limit of $1.5 \mu\text{g}/\text{m}^3$ at all measurement locations. In June 1989, measurements of the Total Suspended Particulates (TSP) smaller than 10 micrometers (PM-10) were initiated. The EPA standards of $50 \mu\text{g}/\text{m}^3$ (annual arithmetic mean) and $150 \mu\text{g}/\text{m}^3$ (24-hour average) were not exceeded at any location.

Environmental compliance activities conducted during 1989 were primarily those concerned with CERCLA requirements. The Monticello millsite was formally listed on EPA's Superfund National Priorities List in October. A Draft Final Remedial Investigation/Feasibility Study--Environmental Assessment (RI/FS--EA) and a Proposed Plan were made available for public review in October. The administrative record for the millsite was placed in the information repository in November. Preparation of the draft Record of Decision (ROD) was initiated late in the year; the ROD is scheduled for issuance in June 1990.

INTRODUCTION

This report presents results of environmental monitoring activities conducted in 1989 at the inactive uranium millsite in Monticello, Utah. The site is included under the U.S. Department of Energy's (DOE) Surplus Facilities Management Program (SFMP). Monitoring and report preparation were performed by UNC Geotech, the DOE contractor for the Grand Junction Projects Office Facility (GJPO) in Grand Junction, Colorado.

The Monticello Millsite is a 31.6-hectare (78-acre) tract located in San Juan County, Utah, adjacent to the city limits of Monticello. The mill area covers approximately 4 hectares (10 acres), the tailings impoundment area covers the remaining 27.5 hectares (68 acres). None of the original mill buildings remain, but contaminated foundations and scrap materials are buried on site. The tailings impoundment area contains almost 1,814,000 metric tons (2 million short tons), or 1,018,800 cubic meters (1,333,333 cubic yards), of tailings and contaminated soil in four discrete piles. An additional 362,800 metric tons (400,000 short tons), or 203,759 cubic meters (266,666 cubic yards), of contaminated material is present on adjacent open lands (Marutzky and others 1985).

Prior to 1955, the environmental problems receiving attention at the Monticello mill arose from the salt roast procedure used to enhance vanadium recovery. An average of nearly 1182 kilograms (2600 pounds) of dust containing 0.363 percent U_3O_8 and 1.52 percent V_2O_5 escaped daily through the roaster stack (Allen and Klemenic 1954). Corrosion of wire fences, clotheslines, and galvanized roofs was verified by the mill operator in response to complaints from local residents.

Liquid effluent from the salt roast/carbonate leach plant, which contained substantial concentrations of chloride, sulfate, carbonate, bicarbonate, sodium, and other dissolved species, was released into Montezuma Creek. Release of radium-226 was of special concern; soluble radium activity in Montezuma Creek was found to be 160 picocuries per liter (pCi/L). It was also recognized that the suspended solids contained considerable radium activity and that dry tailings were being washed into the creek (Whitman and Beverly 1958).

During milling operations, the tailings were normally moist and erosion by wind was therefore minimal. Within a year after shutdown, however, the tailings dams and surfaces of the piles dried out, and tailings sand began to migrate as dunes. Erosion by water also became a problem. Several cleanup activities conducted since the time of mill closure have substantially stabilized the area but have not eliminated water contamination. Extensive studies conducted at Monticello demonstrate that all four tailings piles contribute to the contamination of ground water and surface water, both on and off site.

Responsibility for the administration, maintenance, and environmental monitoring of the inactive uranium millsite and tailings area at Monticello, Utah, formerly operated by the Atomic Energy Commission, resides with the DOE's GJPO. The site was accepted into the SFMP in 1980. Under this program, the chief objective of the Monticello Remedial Action Project is to minimize

potential health hazards to the public that are associated with the tailings at the millsite. In order to provide a basis for making decisions regarding the remediation of the site, an environmental and engineering characterization was completed and documented in the *Monticello Remedial Action Project Site Analysis Report* (Abramiuk and others 1984). In addition, a *Draft Final Remedial Investigation/Feasibility Study--Environmental Assessment (RI/FS--EA) for the Monticello, Utah, Uranium Mill Tailings Site* report was prepared and made available for public review in October 1989; this report was finalized in March 1990.

Previous years of monitoring activity at the Monticello Millsite have clearly defined the contaminant type and distribution in ground water, surface water, and air. Because of the well-defined plume characteristics at the site, monitoring activities were abbreviated in 1989 (as in 1988) to include biannual ground-water and surface-water samplings. Analyses were performed for known contaminants for which standards either exist or are proposed, i.e., gross alpha, radium-226, radium-228, uranium, vanadium, arsenic, selenium, molybdenum, and nitrate. Total alkalinity, pH, and specific conductance were measured as well to identify any change in the general water-quality characteristics. Ambient air monitoring at the site was conducted as in previous years.

This annual environmental monitoring report has been written to appropriate content requirements of DOE Order 5400.1 and the supplemental information received from DOE Headquarters. An Environmental Monitoring Program Plan is currently in preparation; future monitoring reports will conform to both content and format requirements prescribed by this Plan.

ENVIRONMENTAL MONITORING PROGRAM

REGULATIONS REQUIRING MONITORING

Monitoring activities at the Monticello Millsite are conducted in conjunction with planned remediation activities under CERCLA/SARA. The resultant data will provide extensive baseline information prior to initiation of remedial action. The Monticello site was included on the National Priorities List (NPL) in 1989.

QUALITY ASSURANCE

Quality Assurance (QA) measures were incorporated into all of the monitoring activities detailed in this report, and were appropriately documented. General quality assurance policy and procedures, as presented in the *Quality Assurance Manual* (UNC Geotech/Grand Junction Projects Office 1987a), were followed. Other documents consulted to address QA considerations regarding specific measurement and sample-collection procedures were:

- DOE/GJPO *Handbook of Analytical and Sample-Preparation Methods* (UNC Geotech 1988a);
- DOE/GJPO *Administrative Plan and Quality Control Methods for the UNC/GJPO Analytical Laboratories* (UNC Geotech 1988b);
- UNC/GJPO *Environmental Sciences Procedure Manual*, Second Edition (UNC Geotech 1986); and
- SFMP/Monticello Remedial Action Project (MRAP) Quality Assurance Program Plan (QAPP) (UNC Geotech 1987b).

SOURCES OF CONTAMINATION

Radioactive mill tailings compose the principal waste type at the Monticello millsite. Residual uranium ore in old ore stockpile areas at the millsite constitutes only a minor waste type. Historically, environmental concern has focused on the radiological hazards associated with the tailings and ore. However, a number of trace elements typically occur at elevated concentrations in uranium ore. These are not recovered during milling operations, but are passed through the circuit to the tailings piles. Because hazardous organic chemicals were not used in the milling process, the hazardous substances selected for waste characterization are all inorganic.

According to Albrethsen and McGinley (1982), 819,291 metric tons (903,298 short tons) of uranium ore was processed at the Monticello mill between 1948 and 1960 to yield approximately 2077 metric tons (2290 short tons) of uranium oxide, U_3O_8 , and 1061 metric tons (1170 short tons) of vanadium pentoxide, V_2O_5 . Most of the original constituents of the ore, as well as the chemicals added during the milling process, reside in the tailings.

The tailings generated by the milling operations are contained in four piles referred to, in order of their construction, as the Carbonate Pile, Vanadium Pile, Acid Pile, and the East Pile (Figure 1). The Carbonate and Vanadium Piles were formed during the period from 1949 to 1955 when the mill was recovering vanadium as a by-product. The process used for the recovery was a salt roast/carbonate leach flow sheet. The Vanadium Pile is so called because of the high vanadium content of these tailings; it is in no way related to tailings produced by the Vanadium Corporation of America (VCA) mill, which preceded the Atomic Energy Commission (AEC) mill. Use of the Acid Pile commenced about 1955. This pile received tailings from the acid leach resin-in-pulp (RIP) process and a carbonate leach circuit. The East Pile was operated from 1956 until mill shutdown in 1960 and received tailings from the acid leach circuit and the high temperature, carbonate leach RIP circuit.

Photographs taken during the operation of the millsite indicate that earthen berms were initially used to impound the tailings. As the impoundment filled, sandy tailings were apparently used as berm material to maintain the ponds. After closure of the mill, the piles were regraded and stabilized by covering them with pit-run gravel and top soil. Materials from all four tailings piles are available for leaching into the ground and surface water and for release into the atmosphere.

GROUND WATER

Hydrogeology

There are two primary aquifers in the project area. Unconsolidated materials deposited by Montezuma Creek constitute an alluvial aquifer along the valley bottom. An underlying sandstone aquifer, the Burro Canyon Formation, is separated from the alluvial aquifer by the Mancos Shale and by shale units of the Dakota Sandstone, which act as a major aquitard in the project area (Figure 2).

The alluvial aquifer is approximately 3 meters (15 feet) thick near Montezuma Creek and thins gradually toward the valley sides. Montezuma Creek is in hydraulic communication with the aquifer on the upstream side of the East Tailings Pile. However, because of a realignment of the stream channel, the aquifer and Montezuma Creek are separated in the vicinity of the East Tailings Pile. The creek and the aquifer are reunited downstream of the tailings pile.

Sources of recharge to the alluvial aquifer are infiltration of precipitation and surface water and seepage from fractures in the Mancos Shale along the boundary of the alluvial aquifer. Discharge from the alluvial aquifer is estimated to be approximately 113,550 to 132,475 liters (30,000 to 35,000 gallons) per day across the East Tailings Pile. As water traverses the site, water quality is degraded by movement through the tailings. The leachate contributes uranium, vanadium, radium, sulfate, selenium, and molybdenum to ground water in the alluvial aquifer. The alluvial aquifer is not being used for any purpose in the area of the tailings site.

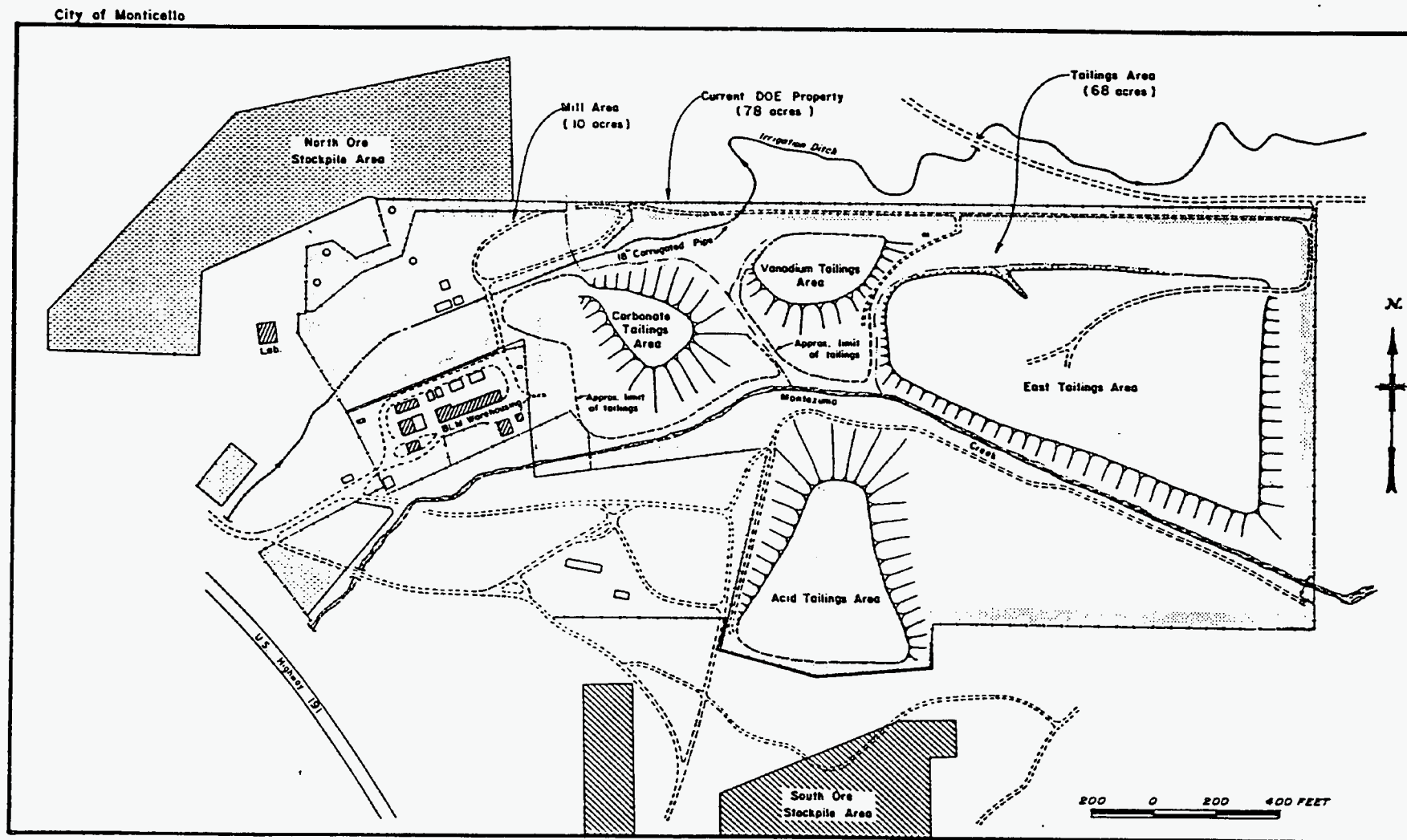


Figure 1. Monticello Millsite Plan

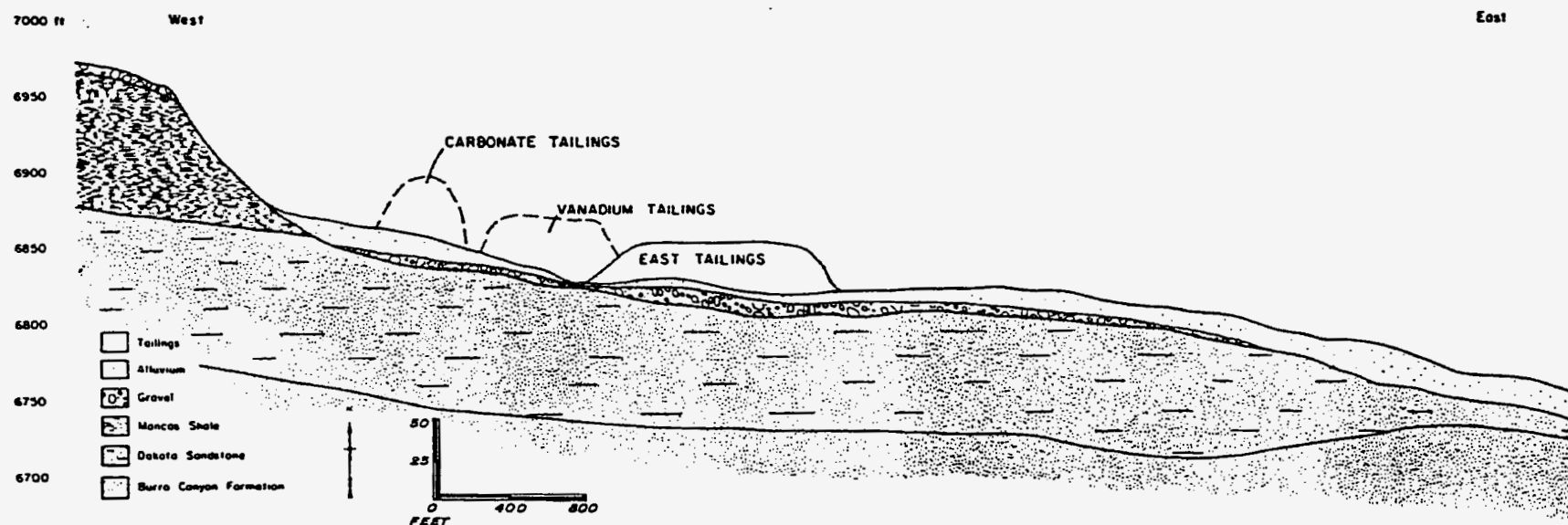


Figure 2. Generalized West-East Cross Section Through the Project Area (Dakota/Burro Canyon based on core data).

The Burro Canyon Formation is a confined aquifer that underlies the alluvial aquifer. It is separated from the alluvial aquifer by an aquitard consisting of the Mancos Shale and silty sandy units of the Dakota Sandstone. The Burro Canyon Formation is tilted and exposed along the margin of the Abajo Dome; this is the recharge zone for the Burro Canyon aquifer. Discharge from the aquifer occurs across the Great Sage Plain, along erosional margins, and in areas where canyons dissect the formation. Numerous stock ponds and marshy areas are created as a result of spring-fed discharge from the Burro Canyon aquifer.

There is presently no evidence from ground-water well samples that the Burro Canyon aquifer is being degraded by the tailings piles. Water in the Burro Canyon aquifer is used occasionally for domestic water supply.

1989 Sampling Results and Comparison to Standards

Ground-water samples were collected from the alluvial aquifer at the Monticello site in May and October of 1989 with a peristaltic pump, a bladder pump, or a Teflon bailer. Thirteen well samples were collected in May, eleven in October; wells 82-9 and 82-13 were not sampled in October because access was denied by the landowner. Because the site had been extensively characterized previously, the frequency of sampling was reduced to twice a year in 1987, 1988, and 1989. Samples requiring filtration were run through a 0.45- μ m filter in line with the collection vessel. Samples were then preserved and analyzed according to procedures prescribed in the *Handbook of Analytical and Sample-Preparation Methods* (UNC Geotech 1988a). Results of selected 1989 well sample analyses (by location) are presented in Tables 1, 2, and 3; results of all 1989 sample analyses are presented in the Appendix. Well locations are shown in Figure 3.

Historically, shallow-aquifer upgradient ground-water-quality data have been acquired from Wells 82-19, -20, -43, and -44. Over the past seven years, elements found in very low concentrations include arsenic, barium, chloride, iron, molybdenum, lead, vanadium, zinc, and radium-226. Concentrations of selenium and manganese have, at times, exceeded applicable standards (Table 4). In 1989, only upgradient wells 82-20 and -43 were sampled; with the exception of nitrate, no measured constituent was above standard.

Ground water sampled on site from the shallow aquifer is contaminated by elements leached from the tailings piles. In general, the highest concentrations of contaminants are found in the vicinity of the Carbonate and Vanadium Piles. Historically, concentrations of arsenic, iron, lead, molybdenum, nitrate, selenium, sulfate, uranium, and radium-226 have, at times, exceeded standards (Table 4). In 1989, arsenic, molybdenum, selenium, uranium, and radium-226 exceeded standards in one or more ground water samples.

Shallow-aquifer downgradient monitoring wells on private property east of the Government property have provided evidence of contaminant migration. Concentrations of chloride, iron, manganese, molybdenum, selenium, sulfate, and uranium have, at times in the past, exceeded standards (Table 4). In 1989, molybdenum, selenium, and uranium were observed in concentrations above standard in one or more downgradient ground-water samples. Even well 82-9, located 0.7 kilometer (0.4 mile) east of the Government property, is contaminated.

Table 1. Maximum Observed Concentrations in Shallow Upgradient Monitoring Wells at the Monticello Millsite

Well	Constituent Concentration ^a							
	Gross Alpha	As	Mo	NO ₃	Ra ₂₂₆	Se	U	V
82-20	<62	<0.01	<0.01	59.1	0.2	<0.005	0.017	<0.05
82-43	<51	<0.01	0.01	15.9	<0.2	<0.005	0.019	<0.05

^aAll results are in mg/L except those for Ra₂₂₆, which are in pCi/L.

Table 2. Maximum Observed Concentrations in Shallow On-Site Monitoring Wells at the Monticello Millsite

Well	Constituent Concentration ^a							
	Gross Alpha	As	Mo	NO ₃	Ra ₂₂₆	Se	U	V
82-30B	637	0.14	0.36	3.45	0.6	0.089	0.666	4.29
82-36A	6127	<0.01	1.34	93.3	16.7	<0.005	5.4	0.272
82-40A	905	0.05	0.222	0.26	3.3	<0.005	0.871	0.5
82-45B	<45	<0.01	0.01	5.74	0.2	<0.005	0.042	<0.05

^aAll results are in mg/L except those for Ra₂₂₆, which are in pCi/L.

Table 3. Maximum Observed Concentrations in Shallow Downgradient Monitoring Wells at the Monticello Millsite

Well	Constituent Concentration ^a							
	Gross Alpha	As	Mo	NO ₃	Ra ₂₂₆	Se	U	V
82-8	94	<0.01	0.015	4.66	0.9	0.02	0.13	<0.05
82-9	590	<0.01	0.13	7.98	0.6	0.038	0.65	<0.05
82-13	292	<0.01	<0.01	0.12	0.2	<0.005	0.44	<0.05

^aAll results are in mg/L except those for Ra₂₂₆, which are in pCi/L.

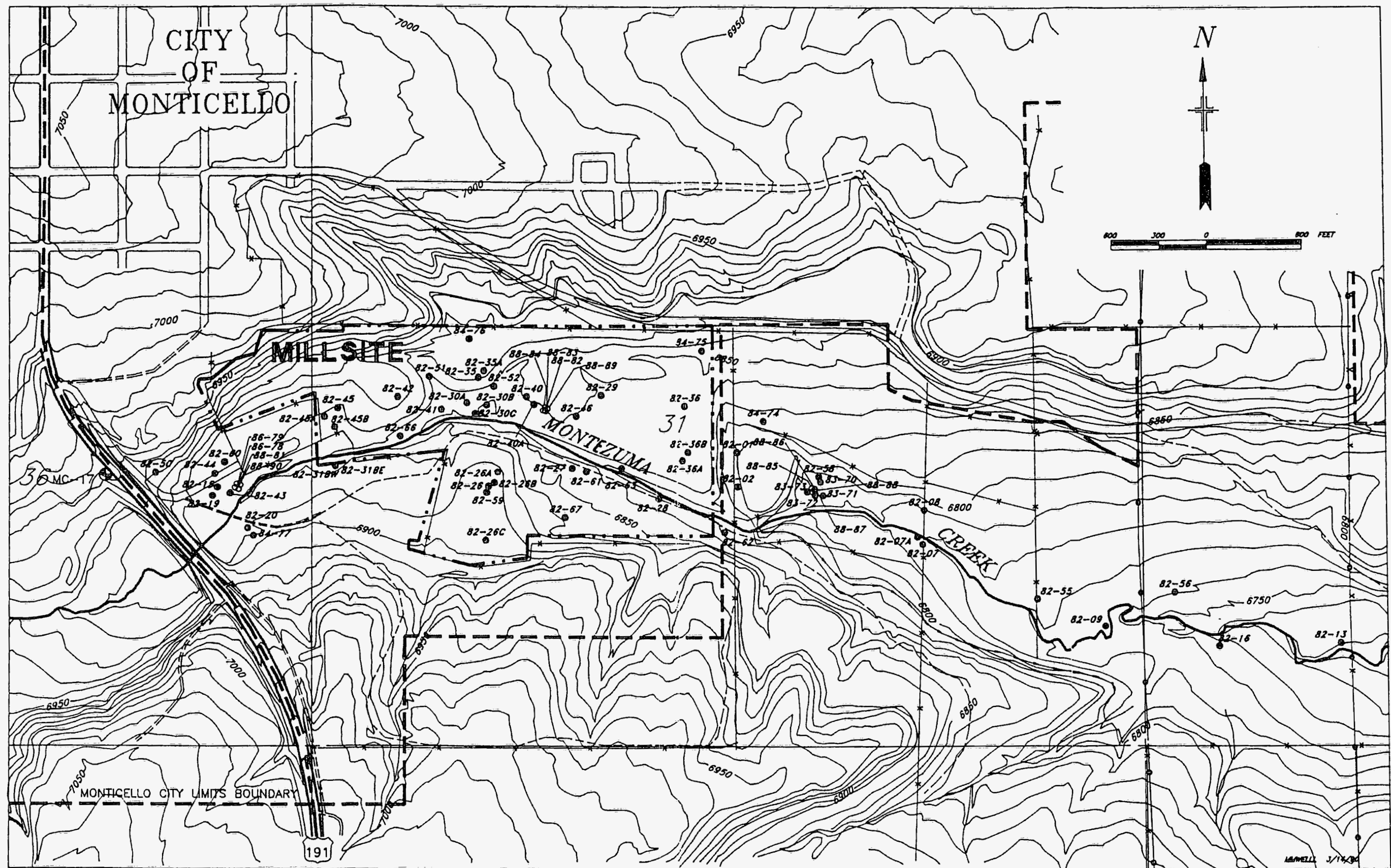


Table 4. Comparison of Maximum Concentrations of Selected Constituents in the Alluvial Aquifer at the Monticello Millsite with EPA and State of Utah Drinking Water Quality Standards, and Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 Ground-Water Standards^a.

Constituent	Standard	1989 Maximum ^b			Historical Maximum ^c		
		Up- gradient	On-Site	Down- gradient	Up- gradient	On-Site	Down- gradient
Arsenic ^d	0.05	<0.01	0.14	<0.01	0.01	0.19	0.02
Barium ^d	1.00	No data	No data	No data	<0.10	0.85	<0.10
Cadmium ^d	0.01	No data	No data	No data	<0.005	0.005	<0.001
Chloride ^e	250	No data	No data	No data	17.9	150	1080
Chromium ^d	0.05	No data	No data	No data	0.01	0.02	<0.01
Fluoride ^{e,f}	1.6	No data	No data	No data	0.20	1.2	0.73
Iron ^e	0.30	No data	No data	No data	0.60	3	0.81
Lead ^d	0.05	No data	No data	No data	<0.025	0.025	<0.01
Manganese ^e	0.05	No data	No data	No data	2.0	21	1.22
Mercury ^d	0.002	No data	No data	No data	0.002	<0.0002	<0.0002
Molybdenum ^g	0.1	0.01	1.34	0.13	0.06	116	0.53
Nitrate ^e	10.00	86.7	93.3	7.89	86.7	160	7.89
pH (S.U.) ^e	6.5-8.5	6.52-6.75	6.68-7.06	6.1-7.18	6.5-8.6	4.5-12.5	6.0-7.8
Selenium ^d	0.01	<0.005	0.085	0.038	0.013	0.16	0.038
Silver ^d	0.05	No data	No data	No data	<0.025	<0.025	<0.010
Sulfate ^e	250	No data	No data	No data	682	3900	1200
Uranium ^g	App. 0.45 ^h	0.02	5.4	0.65	0.096	51	2.3
Zinc ^e	5	No data	No data	No data	2.82	1.40	0.47
Ra ₂₂₆ (pCi/L) ^{d,i}	5	0.3	16.7	0.9	0.30	38	0.9

^aAll values given in mg/L except those designated otherwise. A "<" symbol indicates that the maximum concentration was below detection limits (number shown is detection limit).

^bResults of all 1989 sample analyses are presented in the Appendix.

^cBased on concentrations observed in ground water from 1984 to present.

^dStandard under EPA, the State of Utah, and UMTRCA.

^eStandard under EPA and the State of Utah.

^fThe EPA standard is 4 mg/L, while the Utah standard is 1.6 to 2.1 mg/L.

^gConstituent listed only as an UMTRCA standard.

^hStandard is actually 30 pCi/L. For comparison purposes, this activity was converted to concentration, assuming equilibrium. The activity is approximately 0.666 pCi/μg because of both U₂₃₈ and U₂₃₄.

ⁱUMTRCA standard includes both Ra₂₂₆ and Ra₂₂₈.

SURFACE WATER

Description

Montezuma Creek is the main surface water body in the project area. Contaminant concentrations in the creek increase downstream of the site because of the mixing of the creek with alluvial-aquifer discharge. Surface water constitutes a source of municipal water supply about 1.6 kilometers (1 mile) upstream of the tailings area. Downstream of the tailings area, surface water is used primarily for stock watering.

Background surface-water quality is monitored at site W-3, shown in Figure 4. This sampling point is located east of the culvert under U.S. Highway 191. In past years, upstream samples (site I-1) have been collected to verify that the W-3 site accurately represents the background water quality of Montezuma Creek (Korte and Thul, 1982, 1983). Historically, elements either not detected or found in very low concentrations have included arsenic, barium, chromium, iron, lead, manganese, molybdenum, selenium, uranium, vanadium, and radium-226.

Permanent surface water on the Government property consists of perennial flow in Montezuma Creek and in the drainage between the Carbonate and Vanadium Piles (drainage designated W-2 on the map in Figure 4). There is intermittent water in seeps south of the Carbonate and Vanadium Piles and east of the Acid Pile. Owing to the melting of snow, the Vanadium and Acid Pile seeps contain water in the spring. The seep adjacent to the Vanadium Pile generally covers an area as large as 4.5 square meters (5 square yards) to a depth of 15 to 30 centimeters (8 to 15 inches). The Acid Pile seep is contained by a small dam; when full, this seep is approximately four times larger in area than the Vanadium Pile seep.

The seep adjacent to the Carbonate Pile forms a small pond covering approximately 12.5 square meters (15 square yards). This pond contains water throughout the summer and supports a few cattails; typically, it is the only one of the three seeps that contains water during the dry seasons.

A diversion ditch was constructed north of the East Tailings Pile in 1984 in an attempt to divert some water away from the piles and thereby decrease the volume of contaminated water that seeps out of the piles. Subsequent visual observations, however, did not indicate any decrease in water in the various seeps and small drainages that surround the piles.

Montezuma Creek flows through the middle of the property. Although flow is perennial, it can be quite low during the late summer. There can also be substantial flooding, as occurred in the spring of 1983. Results of earlier studies (Korte and Thul 1982, 1983) indicate that uranium contamination of the creek occurs upgradient of the point at which the creek traverses the tailings piles. However, concentrations of both molybdenum and uranium are typically higher downgradient and off site, which suggests that contributions from the alluvial aquifer to Montezuma Creek are greatest downstream of the Government property.

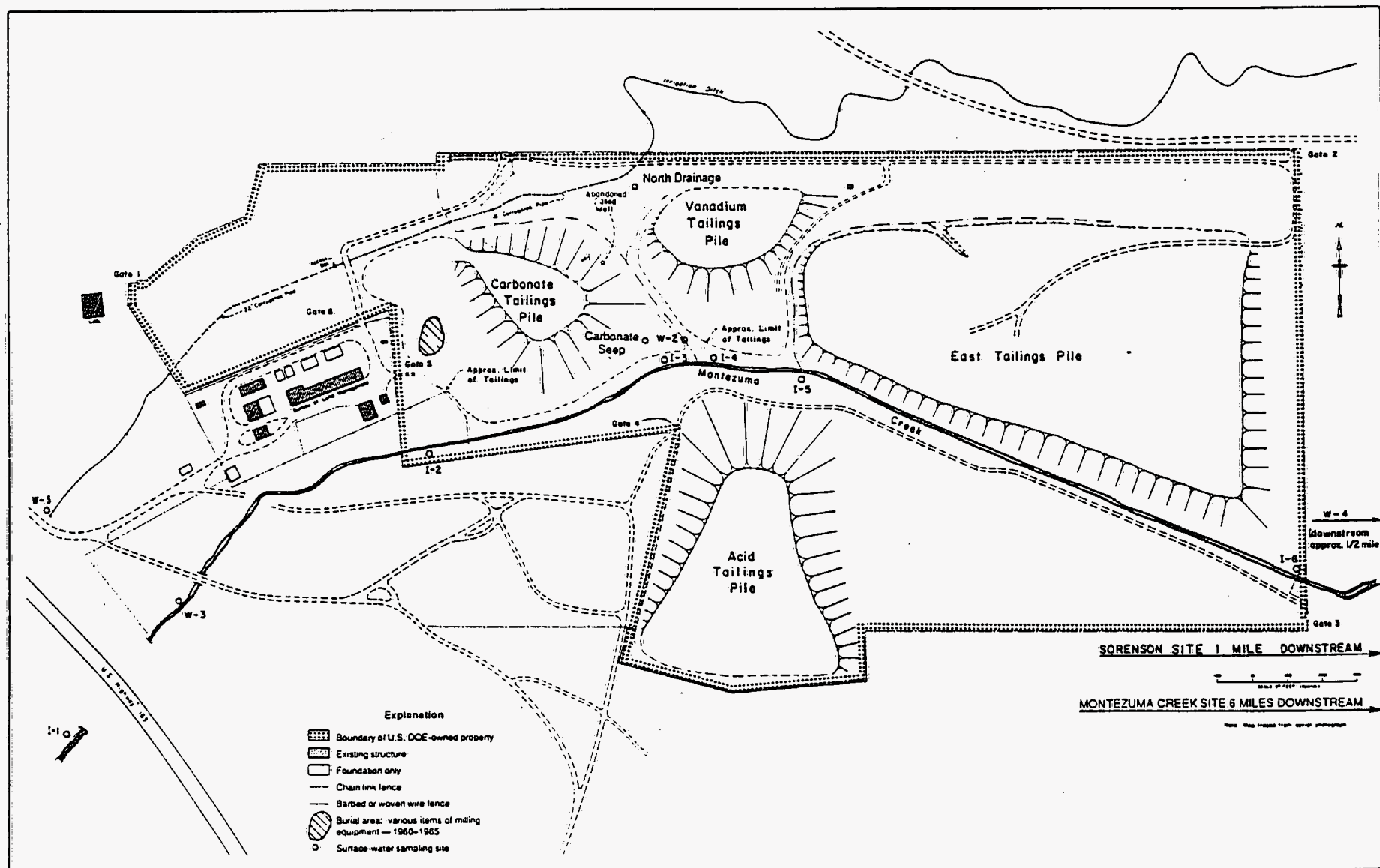


Figure 4. Locations of Surface-Water Sampling Sites at the Monticello Millsite.

Seeps from the shallow aquifer are visible along the creek below the drop structure. Creek flow increases for approximately 2 kilometers (1.25 miles) and is perennial along this stretch. The W-4 sampling site is located approximately 100 meters (325 feet) downstream of the east boundary of the property. Except under conditions of very high flow, as during a storm event or spring runoff, contamination levels frequently exceed State of Utah standards.

Samples have routinely been collected at what is known as the Sorenson site, located approximately 2 kilometers (1.25 miles) downstream of the Government property. Data comparison has shown little decrease in contamination between the W-4 site and the Sorenson site. The shallow aquifer is contaminated as far downgradient as it has been sampled. It is in hydraulic connection with Montezuma Creek and thus sustains high concentrations of the contaminants in the creek for a considerable distance off site. The downstream water quality of Montezuma Creek is described in detail in the Draft Final RI/FS--EA (UNC Geotech, 1989a).

1989 Sampling Results and Comparison to Standards

Surface-water monitoring over the past 8 years at the Monticello site has provided extensive baseline data. Because of this, monitoring activities from 1987 on have been significantly reduced from those of previous years, the primary goal having been to detect only major changes in water chemistry. Locations sampled in 1989 include those designated in Figure 4 as W-2, W-3, W-4, W-5, the Carbonate Seep, the Montezuma Creek site, the Sorenson site, and the North Drainage. Analytical results are provided in the Appendix.

Background surface water at site W-3 in 1989 was characterized by low levels of mill-tailings-related contaminants, an average pH of 8.18, a specific conductance of 1629 μ mhos/cm, and an alkalinity of 141 mg/L (as CaCO_3). These levels are slightly higher than those of years prior to 1988 because of low runoff.

A comparison of data from surface-water samples collected from 1984 through 1989 to State of Utah Surface Water Standards is presented in Table 5. From this table, it can be seen that, historically, upgradient surface water samples have exceeded State of Utah standards with respect to gross alpha, nitrate, and zinc; on-site samples have exceeded standards with respect to arsenic, gross alpha, nitrate, radium-226, selenium, silver, sulfate, and zinc; and downgradient samples have exceeded standards with respect to gross alpha, nitrate, and zinc.

In 1989, maximum concentrations of arsenic, gross alpha, nitrate, radium-226, and selenium measured in on-site samples exceeded their respective surface-water standards (Table 5). Concentrations of molybdenum, uranium, and vanadium also were elevated in some on-site samples, as compared to concentrations of these elements in upgradient samples (see Appendix). Consistent with findings of previous years' monitoring, contamination was greatest in the areas of the Carbonate Seep, location W-2, and the downgradient Sorenson site.

Table 5. Comparison of 1989 and Historic Maximum Concentrations of Selected Constituents in Montezuma Creek with State of Utah Surface Water Standards

Constituent	Standard	1989 Maximum ^{a, b}			Historic Maximum ^{a, c}		
		Up- gradient	On-Site	Down- gradient	Up- gradient	On-Site	Down- gradient
Arsenic	0.05	<0.01 ^d	3.6	<0.01	<0.01	3.6	0.027
Barium	1.0	No Data	No Data	No Data	<0.10	0.85	0.12
Cadmium*	0.010	No Data	No Data	No Data	<0.001	<0.001	<0.001
Chromium*	0.05	No Data	No Data	No Data	<0.005	<0.005	<0.005
Fluoride*	1.4	No Data	No Data	No Data	<1.0	<1.0	<1.0
Gross Alpha 15 (pCi/L)		<33	1148	332	17	1148	332
Iron	1.0	No Data	No Data	No Data	0.10	0.30	0.15
Lead*	0.01	No Data	No Data	No Data	0.003	0.003	0.001
Mercury*	0.002	No Data	No Data	No Data	<0.002	<0.002	<0.002
Nitrate	1.0	0.21	153	23.2	3.0	390.0	23.2
Radium-226 (pCi/L)	5	0.2	10.6	0.4	0.2	23.8	0.4
Radium-228 (pCi/L)	5	<2.0	<3.0	<3.0	<1.0	<5.0	<3.0
Selenium	0.05	0.007	2.03	0.042	0.007	3.11	0.042
Silver*	0.01	No Data	No Data	No Data	<0.0005	0.016	0.002
Sulfate	1000	No Data	No Data	No Data	190	4200	786
Zinc	0.05	No Data	No Data	No Data	1.02	0.33	1.46
pH (S.U.)	6.5-9.0	8.09-8.26	8.9-9.7	6.92-7.26	6.6-8.7	7.7-10	7.2-8.6

^aAll values are in milligrams per liter (mg/L) except where designated otherwise.

^bResults of all 1989 sample analyses are presented in the Appendix.

^cData are from 1984-1989 samplings except those for constituents labeled with an asterisk (*), which are from samplings prior to 1984.

^dA "<" symbol indicates that the maximum concentration was below detection limit (number shown is detection limit).

AIR QUALITY

Atmospheric Radon

Environmental radon measurements were taken at the Monticello site in 1984. The measurements were taken on the pile, at the site boundary, and at off-site locations with Terradex Track Etch® detectors exposed in duplicate, positioned 1 meter (3.3 feet) above ground level. Atmospheric radon continues to be monitored with Track Etch® detectors, although the number of sample locations was reduced from 19 to 8 at the conclusion of the 1984 sampling period (Figure 5). The annual average radon concentrations measured during 1989 are listed in Table 6 (page 20). During this recent measurement period, the annual average radon standard of 0.50 pCi/L above background specified by 40 CFR 192 was exceeded at ST-4, ST-6, and ST-7. These values are consistent with the previous years' annual averages, which indicates a constant rate of radon emission from the piles. The radon emission described in the following section, although measured in a previous year, can be considered representative of the 1989 monitoring period.

Radon Emission

Extensive measurements of radon flux from the tailings piles were taken during 1984; results of these measurements are presented in detail in the Draft Final RI/FS--EA (UNC Geotech 1989a). The data demonstrate that the EPA standard of $20 \text{ pCi} \cdot \text{m}^{-2} \cdot \text{sec}^{-1}$ for radon emission from inactive uranium processing sites is exceeded at all four tailings piles at the Monticello site.

The radon source strength, area, and weighted average radon flux for each tailings pile are presented in Table 7.

Table 7. Radon Source Strength, Area, and Weighted Average Radon Flux for the Monticello Tailings Piles

Tailings Pile	Radon Source Strength (Ci/Yr)	Area (m ²)	Weighted-Average Radon Flux (pCi·m ⁻² ·sec ⁻¹)
Acid Pile	512.7	52,070	312
Carbonate Pile	571.1	23,657	765
Vanadium Pile	88.5	16,216	173
East Pile	<u>401.9</u>	95,746	133
Total	1574.2		

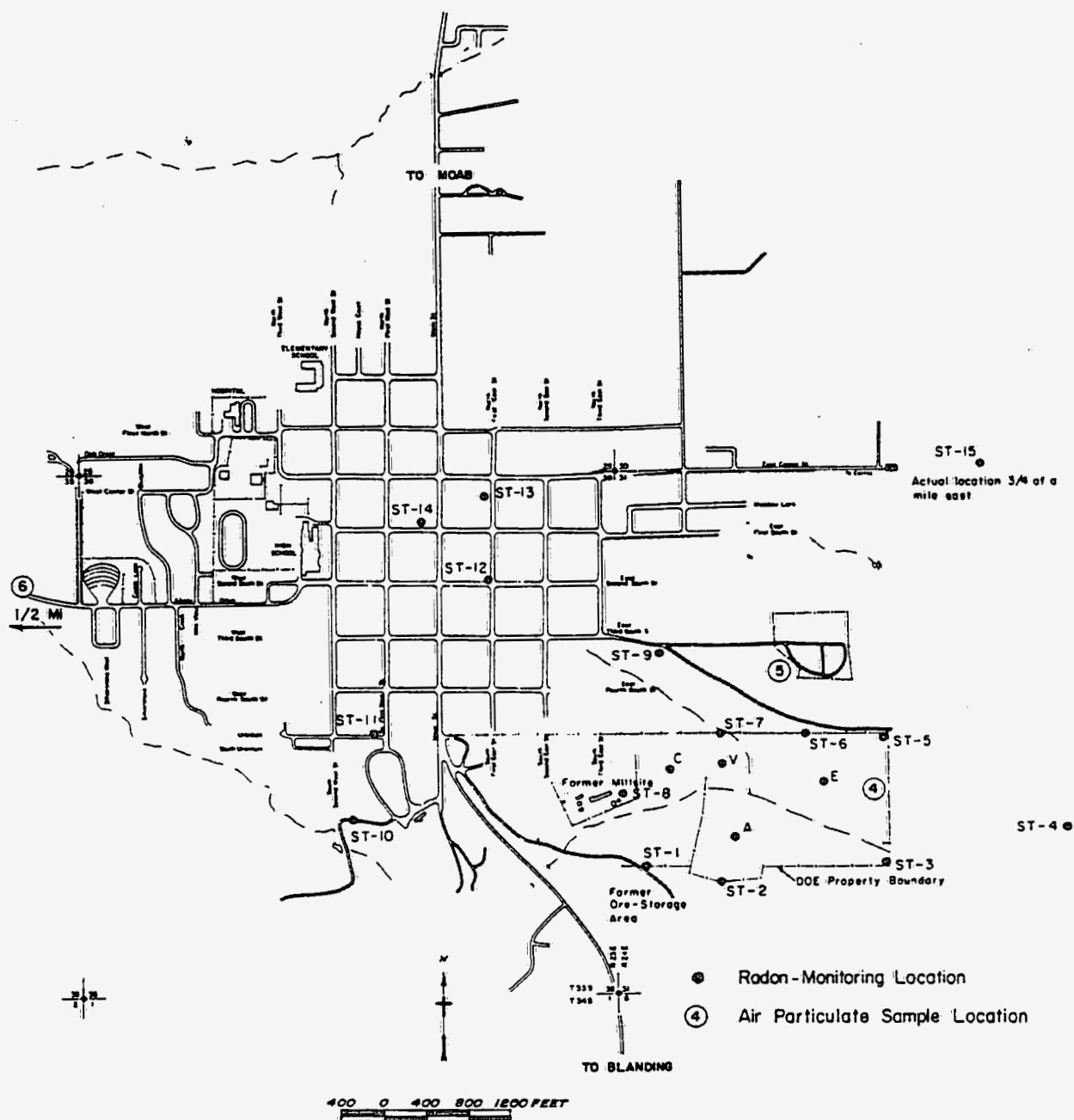


Figure 5. Sampling Locations for Radon and Air Particulate Monitoring in the Monticello Study Area. Ongoing sampling locations are ST-4, -6, -7, -10, -11, -13, -14, and -15.

Table 6. Summary of Radon Concentrations for the Monticello Area
for the Period of 16 November 1988 through 15 November 1989

Sampling Location	Radon Concentration (pCi/L) ^a				
	Annual Average	First Quarter ^b	Second Quarter ^c	Third Quarter ^d	Fourth Quarter ^e
ST-4	1.8	3.3	1.0	1.0	1.9
ST-6	1.3	1.0	0.9	1.1	2.3
ST-7	3.3	3.9	1.7	1.9	5.8
ST-10	0.3	0.3	0.2	0.3	0.4
ST-11	0.2	0.2	0.2	0.1	0.2
ST-13	0.4	0.3	0.5	0.1	0.6
ST-14	0.2	0.1	0.1	0.03	0.4
ST-15	0.4	0.4	0.4	0.4	0.6

^a The units are reported as pCi/L to be consistent with the EPA standard 40 CFR part 192. To convert pCi/L to $\mu\text{Ci/mL}$, multiply by 1×10^{-9} .

^b 16 November 1988 through 15 February 1989.

^c 15 February 1989 through 19 May 1989.

^d 19 May 1989 through 18 August 1989.

^e 18 August 1989 through 15 November 1989.

Air Particulates

Inhalable particulate samplers based on the design by Wedding (1982) were installed at the Monticello site. The Sierra-Anderson samplers are equipped with constant-flow controllers, mechanical timers, and selective inlets. Flow-rate calibration is accomplished with a Kurz Model 341 electronic mass flow meter.

Samplers are operated at 1133 liters per minute (Lpm) (40 cubic feet per minute) for 24 hours, running midnight-to-midnight every sixth day. Sample-collection media are Whatman EPM 2000 glass fiber filters.

Wind-rose data collected on site have clearly identified two principal wind vectors in the area, one to the east and one to the north. Thus, sampling stations were located along these two directions as well as at a background site (Figure 5).

The background site is located approximately 0.5 kilometer (0.3 mile) west of the city of Monticello near the pumphouse building for the city water supply. The intake port for this sampler is 3 meters (10 feet) above ground level. The area west of this site is mostly natural desert and mountainous terrain. There are no nearby industrial activities.

The east site is located on the eastern edge of the East Tailings Pile. The sampler was placed on a steel tower such that the intake was mounted approximately 3 meters (10 feet) above ground level. Limited data was obtained from this sampler during 1989 because the electric power to the station was destroyed during a storm.

The north site is located on the west side of the City of Monticello cemetery grounds. This location is 30 meters (100 feet) north of the tailings area at an elevation 100 meters (330 feet) above the piles. The sampler intake is 4 meters (13 feet) above ground level.

Air-particulate sampling was conducted 31 March through 27 October 1989. (Sampling was suspended prior to 31 March and after 27 October because of inclement weather.) In Table 8 are listed, for all selected elements, maximum concentrations and mean concentrations above detection limits (ADL) measured during the 1989 sampling program.

Comparison to Standards

The EPA standard (40 CFR Part 192) for atmospheric radon concentration at the edge of an inactive uranium mill tailings pile is 0.50 pCi/L above background. If 0.41 pCi/L is used as the average annual background for Monticello (UNC Geotech, 1989a), the site-specific EPA standard is calculated to be 0.91 pCi/L. Examination of the data in Table 6 reveals that the EPA standard is exceeded at both edge-of-pile locations (ST-6 and ST-7). The only off-site location exceeding the standard is ST-4.

Radiologic air particulate levels are regulated at the Monticello site by DOE Order 5480.1 (now superseded by DOE Order 5400.5); the standards applicable to Monticello are given as concentrations above natural background. The reported limits for an uncontrolled area, averaged over one year, are 3×10^{-12} $\mu\text{Ci/mL}$

Table 8. Results of Monticello Air Particulate Study Conducted During 1989

Element	Maximum Concentration			Annual Average Concentration ^a			Number of Samples ^b		
	Station	Station	Station	Station	Station	Station	Station	Station	Station
	4	5	6	4	5	6	4	5	6
	East	North	B.G.	East	North	B.G.	East	North	B.G.
<u>RADIOACTIVE ELEMENTS</u>									
Uranium ($\mu\text{g}/\text{m}^3$)	c	0.0018	0.0018	c	0.0014	0.0015	7(0)	30(11)	33(10)
($\mu\text{Ci}/\text{ml}$)	c	1.2×10^{-15}	1.2×10^{-15}	c	9.5×10^{-16}	1.0×10^{-15}			
Thorium-230 ($\mu\text{Ci}/\text{ml}$)	1.2×10^{-16}	6.7×10^{-16}	8.1×10^{-16}	9.2×10^{-17}	4.5×10^{-16}	4.7×10^{-16}	7(2)	30(15)	33(11)
Radium-226 ($\mu\text{Ci}/\text{ml}$)	c	1.5×10^{-15}	3.0×10^{-15}	c	1.2×10^{-15}	2.0×10^{-15}	7(0)	30(3)	33(4)
<u>NONRADIOLOGIC ELEMENT</u>									
Lead ($\mu\text{g}/\text{m}^3$)	0.0024	1.4896	0.0343	0.0015	0.1103	0.0084	7(7)	30(26)	33(25)
<u>SUSPENDED PARTICULATES</u>									
PM-10 ($\mu\text{g}/\text{m}^3$)	c	63.8	60.7	c	22.6	19.7	0	23	21

^aAverage is calculated using only those values above the minimum detection limit.^bNumber in parentheses indicates number of samples above detection limit.^cAll values were below the detection limit. The average detection limits are $0.0006 \mu\text{g}/\text{m}^3$ uranium and $1.6 \times 10^{-16} \mu\text{Ci}/\text{ml}$ uranium.

radium-226, 8×10^{-14} $\mu\text{Ci/mL}$ thorium-230, and 3×10^{-12} $\mu\text{Ci/mL}$ natural uranium.

Examination of Table 8 shows the highest annual average concentrations of the subject elements (inclusive of background levels) to be 2.0×10^{-15} $\mu\text{Ci/mL}$ radium-226, 4.7×10^{-16} $\mu\text{Ci/mL}$ thorium-230, and 1.0×10^{-15} $\mu\text{Ci/mL}$ natural uranium, values that are clearly below the standard.

Acceptable levels of lead and TSPs smaller than or equal to 10 micrometers (PM-10) are defined by the EPA under the National Ambient Air Quality Standards (NAAQS). The lead standard specifies that a 3-month average concentration is not to exceed $1.5 \mu\text{g/m}^3$; the TSP standard specifies a maximum annual arithmetic mean of $50 \mu\text{g/m}^3$, and a 24-hour concentration not to exceed $150 \mu\text{g/m}^3$. The maximum lead concentration of $1.49 \mu\text{g/m}^3$, the maximum TSP annual average of $22.6 \mu\text{g/m}^3$, and the 24-hour maximum concentration of $63.8 \mu\text{g/m}^3$ measured in 1989 are all within their respective compliance levels.

ENVIRONMENTAL COMPLIANCE ACTIVITIES

The Monticello millsite, because of its level of uranium mill tailings contamination and its inclusion on the National Priorities List, is subject to remedial action under CERCLA/SARA. Items related to the planned remedial action at the site and that necessitate regulatory involvement include those discussed below.

ENVIRONMENTAL MONITORING REPORT

An Environmental Monitoring Report for calendar year 1988 was submitted in 1989 for the Monticello millsite. The report was accepted by DOE-Idaho.

NATIONAL PRIORITIES LIST (NPL)

The Monticello millsite was formally listed on EPA's Superfund National Priorities List (NPL) in October 1989. The listing was based on a Hazard Ranking System (HRS) score of 52.0, which was submitted to EPA Region VIII in October 1987.

PUBLIC REVIEW OF DRAFT FINAL RI/FS--EA AND PROPOSED PLAN

The *Draft Final Remedial Investigation/Feasibility Study--Environmental Assessment for the Monticello, Utah, Uranium Mill Tailings Site*, (UNC Geotech 1989a) and the *Proposed Plan for the Monticello Millsite* (UNC Geotech 1989b) were made available to the public for review on 27 October 1989. The comment period, which included a public meeting in Monticello, Utah, on 16 November 1989, closed on 16 December 1989. Comments received and agency responses will be addressed in a Responsiveness Summary to be published in 1990.

ADMINISTRATIVE RECORD

The administrative record for the Monticello millsite was placed in the information repository at the San Juan County (Utah) Public Library at the start of the public comment period in October 1989. Contained in the record are documents pertaining to the decision-making process for remedial action at the millsite.

RECORD OF DECISION (ROD)

Preparation of the draft Monticello Millsite Record of Decision was initiated in late 1989. The ROD is scheduled to be issued in June 1990.

FEDERAL FACILITY AGREEMENT (FFA)

Work throughout the year was performed in accordance with the mandates of the DOE/EPA/State of Utah Federal Facility Agreement. Numerous meetings, both formal and informal, were held as the three agencies, with input from the public, moved toward agreement on a preferred remedial action at the millsite.

SUMMARY OF POTENTIAL HEALTH EFFECTS

A quantitative assessment of the potential health effects associated with tailings-related contamination is presented in the Draft Final RI/FS--EA (UNC Geotech 1989a). The assessment is based on site-specific data collected from 1981 through 1987. The monitoring data collected in 1989, although more limited in scope, indicate that the ground water and atmospheric radon concentrations are consistent with previous years' values. In view of this, and because there were no operational activities at the site in 1989 that would be expected to cause a significant increase in the source terms, a risk assessment based on the 1989 monitoring data was not undertaken. The following risk estimates, summarized from the Draft Final RI/FS--EA, are therefore considered to be representative of the site during 1989.

The population doses to Monticello residents from natural background radiation and from the tailings piles in their present condition are listed in Table 9.

Table 9. Population Dose Commitments to Monticello Residents from Natural Background and Present Enhanced Conditions

Source	Dose Commitment (man-rem per year)	
	Whole Body	Lung
<u>NATURAL BACKGROUND</u>		
Direct External Exposure	316	
Radon Daughters		1265
<u>ENHANCED CONDITIONS</u>		
Direct External Exposure	0	
Radon Daughters		188

Population dose commitments and potential toxic effects of nonradiologic contaminants associated with the Monticello site are discussed in the Draft Final RI/FS--EA (UNC Geotech 1989a). Although contaminant levels are low, there remains some potential for adverse health effects resulting from chance exposure to nonradiologic contaminants found in Montezuma Creek and soils on the floodplain. However, there have been no incidents reported. The potential for toxicity was derived from a comparison of contaminant levels with acceptable intakes for chronic exposure (AICs).

When average soil concentrations were used, none of the dose levels was exceeded. When maximum soil concentrations were used, copper, uranium, and zinc exceeded the recommended limits for children. However, because of the low population densities along the Montezuma Creek drainage and the land use patterns in the area, it is unlikely that individuals would receive chronic exposures to these maximum concentrations.

Several elements found in Montezuma Creek regularly exceed State and Federal water quality standards: selenium, zinc, manganese, arsenic, and molybdenum. The potential for exposure to these elements dictates that this water should not be used for drinking by humans or cattle. Use of this water to irrigate the alfalfa on which cattle graze appears to be acceptable because average exposure doses do not exceed AICs. However, it is recommended that vegetables not be grown in the Montezuma floodplain.

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APPENDIX

1989 Water Chemistry Data for the Monticello Millsite

1989 Water Chemistry Data for Monticello Millsite

WELL ID	SAMPLE DATE	ALKY (mg/L) (as CaCO ₃)	ALPHA (pCi/L)	AS (mg/L)	BETA (pCi/L)	CDT (µrho/cm)	DTW (feet)	MO (mg/L)	NO ₃ (mg/L)	PH	RA-226 (pCi/L)	RA-228 (pCi/L)	SE (mg/L)	TEMP °C	U (mg/L)	V (mg/L)
82-08	05/09/89	298	94	<0.01	<63	2720	9.64	0.015	4.66	6.41	0.9	<1	0.02	9.8	0.13	<0.05
82-09	05/09/89	386	590	<0.01	290	2194	5.64	0.13	7.89	7.18	0.6	<1	0.038	11.5	0.65	<0.05
82-13	05/09/89	358	292	<0.01	137	2580	5.74	<0.01	0.12	6.91	0.2	<1	<0.005	8.9	0.44	<0.05
82-20	05/09/89	335	<68	<0.01	<64	2685	16.92	<0.01	85.7	6.71	0.3	<1	<0.005	9.2	0.016	<0.05
82-308	05/09/89	364	506	0.14	208	2300	16.59	0.36	3.45	7.05	0.5	<1	0.043	10.1	0.59	4
82-318-EAST	05/09/89	381	<99	<0.01	<126	3200	4.57	<0.01	1.03	6.75	0.5	<1	<0.005	10.9	0.036	<0.05
82-36A	05/09/89	699	6127	<0.01	2695	7200	43.32	1.34	93.3	6.95	16.7	<6	<0.005	11.7	5.4	0.13
82-40A	05/09/89	362	623	0.049	265	2150	20.77	0.222	0.26	6.87	3.2	<1	<0.005	10.9	0.75	0.5
82-43	05/09/89	268	<48	<0.01	<37	2460	9.15	0.01	24.2	6.75	<0.2	<3	<0.005	8.5	0.02	<0.05
82-45B	05/09/89	279	<34	<0.01	<32	1581	4.42	0.01	5.74	6.89	0.2	<1	<0.005	8.9	0.042	<0.05
82-51	05/09/89	379	72	<0.01	<32	1674	9.44	0.01	<0.05	6.92	0.4	<1	<0.005	10.4	0.082	<0.05
82-51 DUP	05/09/89	379	64	<0.01	<32	1674	9.44	<0.01	<0.05	6.92	0.4	<1	<0.005	10.4	0.081	<0.05
82-52	05/09/89	411	75	0.013	34	1754	20.24	0.01	0.14	6.98	0.3	<1	<0.005	11.1	0.12	<0.05
83-74	05/09/89	216	<12	<0.01	<13	614	62.41	0.01	0.07	7.4	1.1	<1	<0.005	11.4	<0.005	<0.05
CARBONATE SEEP	05/09/89	343	2805	1.6	1132	2600	No Data	0.47	0.06	8.8	9.4	<1	0.066	11.2	2	17
MONTEZUMA CREEK	05/09/89	177	89	<0.01	40	1828	No Data	0.02	0.08	8.11	0.3	<1	<0.005	19	0.14	<0.05
NORTH DRAINAGE	05/09/89	337	102	<0.01	47	1739	No Data	<0.01	12.5	7.81	1.6	<1	0.014	6.7	0.19	<0.05
SORENSEN	05/09/89	246	298	<0.01	129	1750	No Data	0.06	10.5	7.99	0.8	<1	0.031	18.2	0.46	0.09
W-2	05/09/89	1148	1424	3.6	653	8560	No Data	6.7	153	8.64	8.9	<1	2.5	7.6	1.2	108
W-3	05/09/89	116	<34	<0.01	<32	1688	No Data	<0.01	0.21	8.26	0.2	<1	<0.005	18.6	0.008	<0.05
W-4	05/09/89	303	327	<0.01	70	2340	No Data	0.07	23.2	7.26	0.4	<1	0.042	12.5	0.49	0.34
W-5	05/09/89	170	<35	<0.01	<32	1699	No Data	<0.01	0.84	8.23	0.1	<1	<0.005	17	0.006	<0.05

1989 Water Chemistry Data for Monticello Millsite (continued)

WELL ID	SAMPLE DATE	ALKY (mg/L) (as CaCO ₃)	ALPHA (pCi/L)	AS (mg/L)	BETA (pCi/L)	CUT (µmho/cm)	DTW (feet)	MO (mg/L)	NO ₃ (mg/L)	PH	RA-226 (pCi/L)	RA-228 (pCi/L)	SE (mg/L)	TEMP °C	U (mg/L)	V (mg/L)
82-08	10/18/89	266	<46	<0.01	<29	1960	10.03	<0.01	2.1	6.1	0.2	<2	<0.005	13.2	0.049	<0.05
82-20	10/18/89	379	<56	<0.01	<30	2170	18.25	<0.01	31.5	6.65	0.1	<2	<0.005	9.2	0.018	<0.05
82-308	10/18/89	410	637	0.035	270	2030	18.72	0.359	0.25	7.06	0.6	<2	0.089	11.6	0.666	4.29
82-318-EAST	10/18/89	426	<66	<0.01	<43	2500	4.52	<0.01	1.85	6.37	<0.1	<2	<0.005	11.9	0.029	<0.05
82-36A	10/18/89	599	3130	<0.01	1962	2200	43.46	0.795	68.3	6.86	14	<4	<0.005	7.7	4.87	0.272
82-40A	10/18/89	408	905	0.05	366	1950	22.47	0.182	<0.04	6.83	3.3	<2	<0.005	10.4	0.871	0.467
82-43	10/18/89	349	<54	<0.01	<29	2130	10.55	<0.01	7.64	6.52	<0.1	<2	<0.005	9.9	0.019	<0.05
82-45B	10/18/89	327	<45	<0.01	<29	1840	5.41	<0.01	5.44	6.68	0.2	<2	<0.005	12.2	0.041	<0.05
82-51	10/18/89	347	38	<0.01	26	1470	10.78	<0.01	0.04	6.74	0.2	<2	<0.005	10.1	0.063	<0.05
82-51 DUP	10/18/89	No Data	46	<0.01	20	No Data	No Data	<0.01	<0.04	No Data	0.3	<2	<0.005	No Data	0.062	<0.05
82-52	10/18/89	369	68	<0.01	39	1430	22.48	<0.01	0.69	6.8	0.7	<2	<0.005	13	0.106	0.126
83-74	10/18/89	229	<11	<0.01	<9	580	62.88	<0.01	<0.04	7.46	1.3	<2	<0.005	11.7	<0.005	<0.05
CARBONATE SEEP	10/18/89	555	6425	1.53	3376	4100	No Data	0.751	0.2	8.43	14.2	<5	0.043	12.8	8.14	27.7
MONTEZUMA CREEK	10/18/89	259	<35	<0.01	41	1550	No Data	<0.01	0.17	7.95	0.2	<2	<0.005	10.9	0.034	<0.05
NORTH DRAINAGE	10/18/89	277	23	<0.01	16	600	No Data	<0.01	34.4	7.6	3.3	<3	0.016	12.9	0.041	<0.05
SORENSEN	10/18/89	353	455	<0.01	187	1900	No Data	0.049	1.12	7.85	1.6	<2	0.005	11.2	0.498	<0.05
W-2	10/18/89	560	1146	No Data	564	5930	No Data	5.05	101	9.7	10.6	<3	2.03	16.5	1.58	97.1
W-3	10/18/89	165	<33	<0.01	<18	1570	No Data	<0.01	<0.04	8.09	<0.1	<2	0.007	9.2	0.008	0.142
W-4	10/18/89	366	332	<0.01	163	1830	No Data	0.052	5.71	6.92	0.3	<3	0.013	12.3	0.444	0.358
W-5	10/18/89	383	<19	<0.01	<11	1830	No Data	<0.01	0.76	7.9	0.2	<2	<0.005	8.5	0.007	<0.05